# A LOWER CARBONIFEROUS CONODONT FAUNA FROM EAST CORNWALL

*by* S. C. MATTHEWS

ABSTRACT. Abundant moulds of conodonts have been collected from a Lower Carboniferous siliceous shale in east Cornwall. Careful inspection of the distribution of moulds produces no evidence of assemblages. The conodonts, studied as latex casts, show the association of Dinantian forms typical of Voges's *anchoralis*-Zone, but include, in addition, certain forms currently regarded as limited to ranges in the Upper Devonian. The stratigraphic circumstances of this example of recurrence of form are examined.

THE Lower Carboniferous around St. Mellion in east Cornwall contains conodont material sufficiently well preserved to serve as a means of dating particular parts of the succession. There is a reference to the siliceous Lower Carboniferous rocks there in Hinde and Fox (1896), and Hinde was the leading student of conodonts in his time. However, in 1896 he and Fox were concerned to record the radiolarian content of these rocks in the ground west of Dartmoor, and they left no note of having observed the conodonts which occasionally appear on parting-surfaces. The first report of conodonts from this same siliceous sequence appeared much more recently (Matthews 1961).

The single occurrence of conodonts briefly noticed in 1961 is discussed more fully here, and with three purposes in mind. One is to offer an example of the usefulness of latex impressions in dealing with occurrences of moulds of these small fossils. A second is to check this Cornish association of forms against associations reported from the Lower Carboniferous of Germany. The third involves explanation of the meaning of the presence of a few 'Upper Devonian' forms in this Lower Carboniferous fauna in Cornwall.

The Lower Carboniferous of the St. Mellion area in east Cornwall exists in two different structural situations: as part of the generally inverted pile of Upper Devonian, Lower Carboniferous, and Upper Carboniferous rocks which is found to be faulted into the belt of Upper Devonian slate outcrop south of Callington, or in isolated *klippen* which apparently have no relation to elements in the lower structure of the district. One such *klippe* can be mapped on Viverdon Down south of Callington. It proves to include a lower rock succession in which siltstones predominate, but which has also beds of material of sand grade. From this lower succession a Tournaisian cephalopod fauna has been recorded (Matthews, 1965). The higher succession in the *klippe* has consistently siliceous rocks, generally of fine grain-size, and best described by the German term *Kieselschiefer*. Within this consistently siliceous succession and roughly 100 ft. above the cephalopod horizon (as judged by field mapping) there is the occurrence of conodonts discussed here.

The conodont locality is in an old quarry on the northern side of Viverdon Down (National Grid Reference SX 375676). At the rear of a ledge some 6 ft. above the western end of the present quarry floor there is a 2-in. thickness of siliceous shale which reveals on its parting-surfaces crowds of what prove to be moulds of conodonts. This particularly prolific occurrence includes any form to be found elsewhere in the quarry.

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In many cases the moulds hold fragile ferruginous casts of the conodonts, 'limonite' replacing the original phosphatic substance of the fossils.

Conodonts are usually collected from residues of disaggregated rocks which greatly reduces the possibility of recognizing any systematic spatial association of forms. In the present case the rock is fine grained, the environment of sedimentation was apparently one of relatively low energy, and conodonts can be seen as they lie within their rock-matrix. It seemed worthwhile to search the parting-surfaces for any suggestion of survival of organized distribution; but none of the observable arrangements of forms could be argued to be other than fortuitous (Pl. 50). Possibly, after arrival in the sediment, the conodonts may have been disarranged by the activity of an endofauna.

The preservation appears to be exactly that encountered by Branson and Mehl (1941*b*) in the material from the Harz (see also Meyer 1965) which they used in their comparison of American and European conodont genera. In collecting material of this kind it is important to retain the two opposing surfaces which a parting provides, for they record details of two different aspects of single specimens. A latex solution, such as Revultex, can be used to prepare positives. In the present case, black Revultex casts were dusted with white ammonium chloride sublimate and photographed. A few drops of detergent were added to the Revultex in order to reduce the surface tension. The casting-process, repeated several times, is useful also as a means of clearing the moulds of their limonitic contents.

Forms identified are:

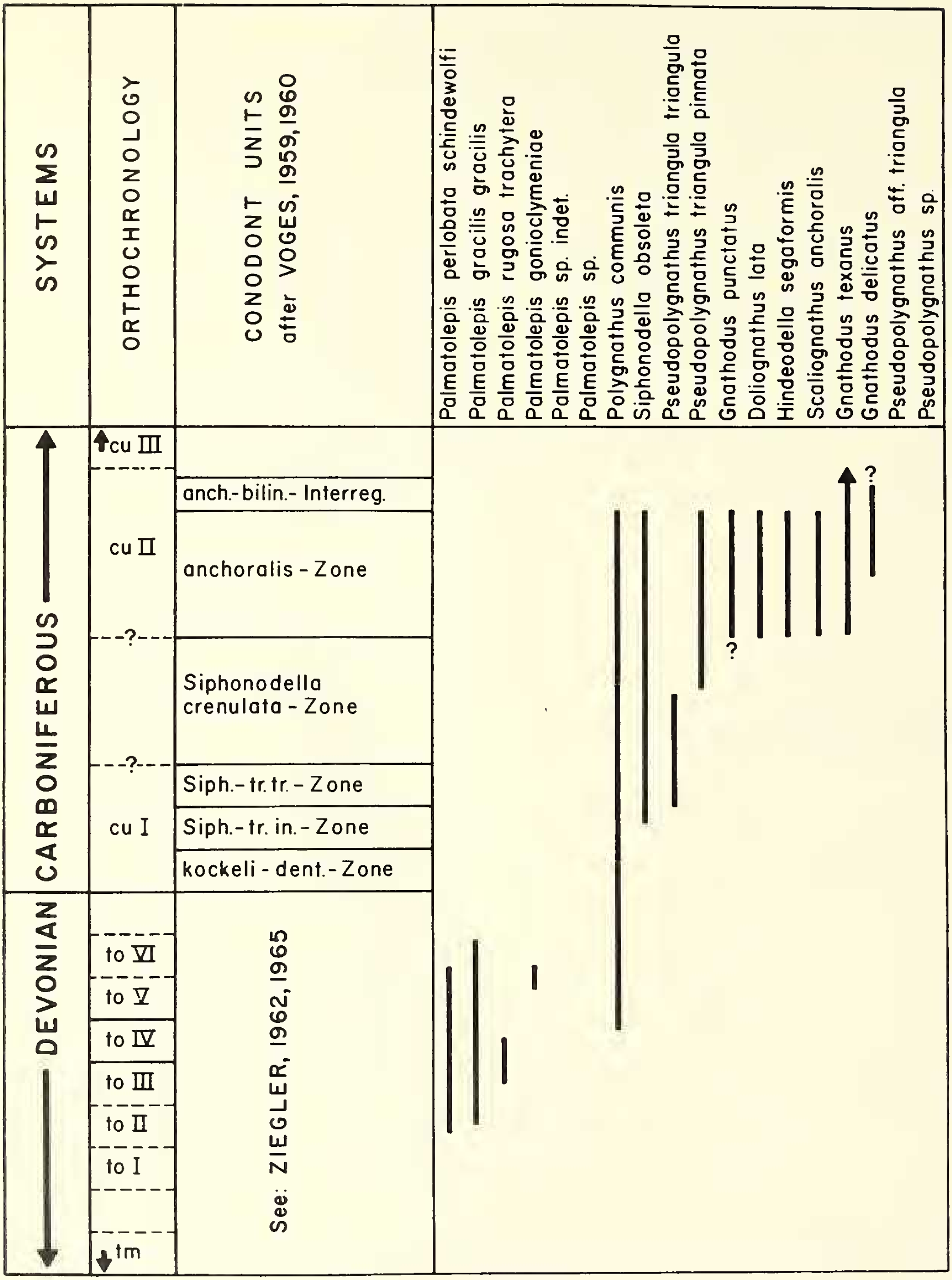
*Doliognathus lata* Branson and Mehl
*Gnathodus delicatus* Branson and Mehl
*Gnathodus punctatus* (Cooper)
*Gnathodus texanus* Roundy
*Hindeodella segaformis* Bischoff
*Palmatolepis gracilis gracilis* Branson and Mehl
*Palmatolepis gonioclymeniae* Müller
*Palmatolepis perlobata schindewolfi* Müller
*Palmatolepis rugosa trachytera* Ziegler
*Palmatolepis* sp. indet.
*Palmatolepis* sp.
*Polygnathus communis* Branson and Mehl
*Pseudopolygnathus triangula pinnata* Voges
*Pseudopolygnathus triangula triangula* Voges
*Pseudopolygnathus* aff. *triangula* Voges
*Pseudopolygnathus* sp.
*Scaliognathus anchoralis* Branson and Mehl
*Siphonodella obsoleta* Hass

In addition there are abundant representatives of the bar genera *Bryantodus*, *Hindeodella* (other than *H. segaformis*), *Ligonodina*, *Lonchodina* and *Neoprioniodus*. The detail of these long-ranging forms need not be recorded here.

No count of individuals is given. Broken or incompletely exposed specimens would tend to blur the meaning of any such count. Also, the surfaces on which conodonts are exposed do not necessarily coincide with bedding, and this, too, would diminish the significance of any tally of exposed individuals. All of the forms identified above are so oriented with respect to the local parting surface as to allow a satisfactory check of species-characteristics. Gnathodids, for example, can be referred to specific categories where an oral-surface is seen, but specific determination is rarely possible if the lateral aspect only is available.

Voges's (1959) findings serve as a standard for dating. It can be seen that the Viverdon Down fauna and Voges's *anchoralis*-Zone faunas have a number of features in common (cf. text-fig. 1):

1. Voges nominated *Scaliognathus anchoralis*, *Hindeodella segaformis* and *Doliognathus lata* as *anchoralis*-Zone indices. All three are represented in the Viverdon Down fauna.




TEXT-FIG. 1. Ranges of conodonts identified in the Viverdon Down fauna, from Ziegler (1962) for the Upper Devonian and Voges (1959) for the early Carboniferous. For further information on *Pseudopolygnathus triangula triangula* and on *Gnathodus delicatus*, see remarks in the text. Association of orthochronology and conodont-chronology after Ziegler (1962, 1965) for the Devonian, and according to the author's own observations for the early Carboniferous.

2. *Pseudopolygnathus triangula pinnata*, also well represented, is found to be confined to the *anchoralis*-Zone (although it should be noted that Collinson, Scott, and Rexroad (1962) reported an abundance of *Ps. triangula pinnata* in their *Bactrognathus-Polygnathus communis* Zone, which has none of the definitive characteristics of the German *anchoralis*-Zone association).

3. In the Sauerland, the *anchoralis*-Zone has some few, late siphonodellids. *Siphonodella obsoleta* can be recognized in the Viverdon Down material.

4. The pattern of gnathodid occurrence is repeated. The presence of *Gnathodus delicatus* would, according to Voges, indicate the later part of the *anchoralis*-Zone and equivalence with the Erdbacherkalk; but subsequent information (Ziegler 1960) suggests that this refinement of the date would not be permissible.

5. Voges found palmatolepids in the *anchoralis*-Zone, and an assortment of such forms can be identified here. It is insufficient to see in this merely a further instance of common character. Voges recorded his palmatolepids as having been reworked. The possible significance of the Cornubian example of recurrence is treated below.

The Viverdon Down fauna plainly bears the stamp of the German *anchoralis*-Zone association, whose character and derivation has recently been restated in closer detail by Meischner (in press). It is satisfactory to discover a full range of comparability, for this suggests free intermigration of conodontifers. The age-correlation is then more firmly founded than one based on isolated individuals.

Translation of the conclusion on age into cephalopod terms is not a straightforward matter. Voges (1960) tentatively equated his *anchoralis*-Zone with cu II$\beta/\gamma$ in the approved (cephalopod-based) orthochronology, although recognizing that the *anchoralis*-Zone did not continue to the upper limit of the Erdbacherkalk, the typical expression of cuII$\gamma$. More recently, Belgian evidence (Conil, Lys, and Mauvier 1964) has suggested that *Scaliognathus anchoralis* occurs in that part of the Belgian stratigraphic sequence which produced the *Ammonellipsites princeps–Muensteroceras complanatum* cephalopod fauna taken by Schmidt (1925) to define cuII$\alpha$. It would be right to conclude from these observations that the Viverdon Down conodont fauna is of cuII age (without closer specification) in cephalopod terms, and to conclude in addition that any future attempt to subdivide on a time basis the conodont faunas of the *anchoralis*-Zone need accept no obligation to account for cuII$\alpha$, $\beta$, nor $\gamma$.

## PALMATOLEPIDS IN THE LOWER CARBONIFEROUS

Voges saw the palmatolepids in the *anchoralis*-Zone as having been reworked. Krebs (1963, 1964) later added further records of Lower Carboniferous occurrences of Upper Devonian forms and discussed the implications of reworking of conodont material. It is now clear that such anomalies, rather than bringing only confusion to the business of dating sedimentary rocks, may instead be made to yield useful information on sources of sediment and so may be of some assistance in indicating relative highs in the palaeogeography.

There appear to be three possible approaches to an interpretation of this recurrence of palmatolepid form observed in the Lower Carboniferous of east Cornwall. One might first consider the question of extending the ranges of these forms. But the full German evidence from the earliest Carboniferous sequences would discredit any such suggestion.

The limits of occurrence seen in the Upper Devonian by Ziegler (1962) can be accepted as real. A hint of an alternative exists in the growing record of cases of 'homoeomorphy' in conodonts (Müller 1962). In order that such a proposal might command acceptance, it would be necessary to demonstrate emergence of palmatolepid form out of some incontrovertibly Dinantian archetype. This cannot be done at the present time (although it might be observed that we are almost equally ill-informed as to the antecedence of such forms as *Scaliognathus*) and proof appears unlikely to come later, for it is not easy to conceive of such a faithful Carboniferous counterfeiting of several different examples of Devonian form. The suggestion of regeneration perhaps best deserves mention for the reason that the third possible means of explaining recurrence is also incapable of producing a firm conclusion. The third course would look to the evidence of stratigraphy in order to make a case for mechanical reintroduction (reworking) and the evidence of this kind, at the site of recurrence, does little to justify reworking as an explanation. The sequence there is to all appearances conformable, and to support this suggestion there is the presence, at a slightly lower horizon, of a Tournaisian cephalopod fauna. No conglomeratic development nor any other indication of delivery of coarse clastic sediment is to be found. Instead, the rock-matrix is so fine as to imply that the conodonts in their original physical condition would have been larger and heavier than any other particle in the accumulate. There is nothing to be seen in the palmatolepid specimens (so far as can be judged from moulds or latex pulls) which would indicate a degree of mechanical wear beyond any experienced by (for example) the *anchoralis*-Zone indices present. Altogether, the local evidence produces little hint of the nature of any physical process by which reintroduction of the palmatolepids might have been effected. Krebs (1963, 1964) has, however, recognized comparable cases in Germany and has proposed that the 'admixed' conodonts were swept from highs in the submarine topography of the time. He has succeeded in identifying such sources in the Upper Devonian fillings of pockets in, or on, reef limestone masses of Middle or early Upper Devonian age. The significance of these as sources is in the fact that they must represent almost a minimum case of Upper Devonian stratigraphic thickness, with little other than conodonts to yield to the basin sequence of the surrounding area during Dinantian time. It is his success in identifying potential source-situations at, or near, the upper surface of the massive limestone developments that particularly commends Krebs's case for reworking. Rather than proceed to assume parallel stratigraphic accidents in south-west England, however, it would be right to see that the proof of reworking of palmatolepids remains to be sought by closer study of the Devonian as well as the Carboniferous stratigraphy there. One thing is clear: it is not necessary to see in any hint of Upper Devonian conodonts reworked in the Lower Carboniferous a suggestion of uplift, nor of emergence, nor of the workings of an early Variscan fold-phase.

## SYSTEMATIC DESCRIPTIONS

The material described here is deposited in the Museum of the Geology Department of the University of Bristol. Five-figure numbers prefixed BU identify rock-specimens, and also a conodont mould if only one is available on the surface of that rock-specimen. Suffixes to the five-figure numbers locate particular conodont moulds where several are present on the surface of one rock-specimen. It will be understood that two different numbers may then refer to two different aspects of one conodont.

The synonymies of the forms treated have been discussed in a number of recent works, and these sources can be cited here, where relevant, without repetition of detail.

### Genus DOLIOGNATHUS Branson and Mehl 1941
### *Doliognathus lata* Branson and Mehl 1941

Plate 46, figs. 5–11

1941*a* *Doliognathus lata* Branson and Mehl, pp. 100–1, pl. 19, figs. 22–6.
1967 *Doliognathus lata* Branson and Mehl; Thompson, p. 34, pl. 2, figs. 11, 14, 17, 19, 20, 22 (with synonymy).

*Material.* BU 19203/2, 3; BU 19205/8, 10; BU 19209/1; BU 19210/1; BU 19212/1; BU 19217/2; BU 19218/11, 14, 20; BU 19219/1, 12.

*Remarks.* The doliognathids seen here have, in every case, relatively restricted basal cavities. The lateral process is well developed. Some specimens show on the lateral process a secondary carina whose constituent nodes tend to be discrete, and which does not continue proximally to meet the main carina. One such (Pl. 46, fig. 6) shows these characteristics and also a tendency for the peripheral ornamentation to be node-like rather than ridge-like and radial. Also, there is a more elongate form (Pl. 46, fig. 8) whose peripheral ornament is much reduced, especially on the main lobe. However, the presence of a well-formed secondary carina and the relative smallness of the basal cavity serve to separate this form from *D. dubia*.

### Genus GNATHODUS Pander 1856
### *Gnathodus delicatus* Branson and Mehl 1938

Plate 46, fig. 4

1938 *Gnathodus delicatus* Branson and Mehl, p. 144, pl. 34, figs. 25–7.
1967 *Gnathodus delicatus* Branson and Mehl; Thompson, pp. 39–40, pl. 3, figs. 1, 6.
?1967 *Gnathodus delicatus* Branson and Mehl, s. 1; Boogaert, p. 179, pl. 2, figs. 13–15 (with synonymy).
?1967 *Gnathodus sp.* cf. *G. bilineatus* (Roundy); Thompson, p. 37, pl. 3, figs. 8, 10, 12, 17.

*Material.* BU 19215.

*Remarks.* The specimen identified here corresponds in character with the earlier form of *G. delicatus* distinguished by Boogaert (1967). The proper affiliation of that author's later, broader variant of *G. delicatus* may emerge from a more detailed analysis of the *Goniatites*–Stufe gnathodids.

### *Gnathodus punctatus* (Cooper, 1939)

Plate 46, fig. 2

1939 *Dryphenotus punctatus* (Cooper); p. 386, pl. 41, figs. 42, 43; pl. 42, figs. 10, 11.
1965 *Gnathodus punctatus* (Cooper); Budinger, p. 58–9 (with synonymy).
1967 *Gnathodus punctatus* (Cooper); Boogaert, p. 179, pl. 2, fig. 19.
1967 *Gnathodus punctatus* (Cooper); Thompson, pp. 40–1, pl. 5, figs. 12–15 (with synonymy).

*Material.* BU 19203/8; BU 19220.

*Remarks.* The material available here includes one large specimen which shows the concave-outward course of the curved line of nodes on the outer side of the carina. This mould of an oral surface is available on a splinter of rock too small to allow preparation of a latex pull. The other specimen, which is figured, is smaller, lacks the curved arrangement of nodes, and is interpreted (following Voges) as a *G. punctatus* variant.

*Gnathodus texanus* Roundy 1926

Plate 46, fig. 3

1926 *Gnathodus texanus* Roundy *in* Roundy, Girty, and Goldman, p. 12, pl. 2, figs. 7, 8.

*Gnathodus texanus* group

*Material.* BU 19203/1; BU 19205/6; BU 19218/27; 32, BU 19219/17.

*Remarks.* Voges (1959) treating the early Carboniferous gnathodids, made distinctions between species mainly by reference to the pattern of ornament developed on the oral surface of the cup. He included under the name *Gnathodus texanus* Roundy a range of forms which departed, in several respects of ornamentation, from the relatively simple type of Roundy (1926), but proposed to be guided by the characteristic outline of the cup in referring these to *G. texanus.* An exception was made in the case of the form given the name *G. girtyi* by Hass (1953). Ziegler (1963), aware of new opinion then forming in North America, used the term *Gnathodus texanus* s.l. in referring to a further German occurrence of such forms. In 1964, Rexroad and Scott proposed a more narrowly drawn set of specific categories to accommodate texanoid and girtyoid forms. Budinger (1965), writing before Rexroad and Scott's proposals were available to him, distinguished several *G. texanus* variants. For these, Boogaert (1967) has offered a reconciliation with Rexroad and Scott's specific categories. Thompson (1967), like van Adrichem Boogaert, uses Rexroad and Scott's set of names.

It is necessary to ask whether Rexroad and Scott's analysis fully accounts for the texanoid gnathodids. The query is justified by the evidence of an interruption of the Mississippian sequence as can be suspected from what is seen in Collinson, Scott, and Rexroad's charts of 1962 and which is plainly admitted in fig. 1 of Rexroad and Scott (1964). The incomplete state of their stratigraphic record may be transmitted to their taxonomic analysis and detracts too, from the credibility of their suggestions on phylogeny. The gnathodids of the *anchoralis*-Zone association deserve restudy, especially the broader texanoids and their variants which approach *G. delicatus.* Until such a study has been carried out, on a stratigraphically acceptable body of material, it seems good to continue to adopt a conservative attitude to the *Gnathodus* species.

EXPLANATION OF PLATE 46

Revultex pulls dusted with ammonium chloride. All magnifications ×30.

Fig. 1. *Siphonodella obsoleta* Hass. BU 19205/7.

Fig. 2. *Gnathodus punctatus* (Cooper). BU 19219/20.

Fig. 3. *Gnathodus texanus* (Roundy). BU 19210/27.

Fig. 4. *Gnathodus delicatus* Branson and Mehl. BU 19215.

Figs. 5–11. *Doliognathus lata* Branson and Mehl. 5, Oral view, BU 19218/20. 6, Oral view, BU 19218/11. 7, Aboral view, BU 19219, of the individual seen in 5. 8, Oral view, BU 19219/1, of an elongate form. 9, Aboral view, BU 19205/8. 10, Oral view, BU 19205/10. 11, Oral view, BU 19210.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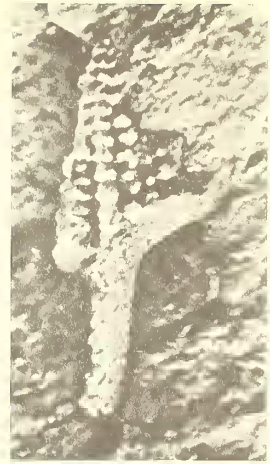
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### Genus PALMATOLEPIS Ulrich and Bassler 1926
### *Palmatolepis gonioclymeniae* Müller 1956

Plate 47, figs. 5, 6

1956 *Palmatolepis* (*Palmatolepis*) *gonioclymeniae* Müller, pp. 26–7, pl. 7, figs. 12, 16, 17, 19.
1962 *Palmatolepis gonioclymeniae* Müller; Ziegler, pp. 59–60, pl. 3, figs. 29–31 (with synonymy).

*Material*. BU 19218/28; BU 19219/19.

*Remarks*. The blade is seen to bend at a point anterior to the central node. The area of the outer side of the platform exceeds that of the inner.

### *Palmatolepis gracilis gracilis* Branson and Mehl 1934

Plate 47, fig. 9

1934 *Palmatolepis gracilis* Branson and Mehl, p. 238, pl. 18, figs. 2, 8.
1966 *Palmatolepis gracilis gracilis* Branson and Mehl; Klapper, p. 31, pl. 6, fig. 3.
1966 *Palmatolepis gracilis gracilis* Branson and Mehl; Glenister and Klapper, 1966, pp. 514–15, pl. 90, fig. 6 (with synonymy).
1967 *Palmatolepis gracilis gracilis* Branson and Mehl; Boogaert, pp. 182–3, pl. 2, figs. 28–9.

*Material*. BU 19218/25.

*Remarks*. The form present here is the one formerly referred to *Palmatolepis* (*Deflectolepis*) *deflectens* Müller 1956. Glenister and Klapper (1966) have explained how the neotype of *P. gracilis* falls within the range of variation of *P. deflectens*, which therefore lapses into junior synonymy.

### *Palmatolepis perlobata schindewolfi* Müller 1956

Plate 47, figs. 1–3

1956 *Palmatolepis* (*Palmatolepis*) *schindewolfi* Müller, pp. 27–8, pl. 8, figs. 22–3, 25–31, pl. 9, fig. 33.
?1968 *Palmatolepis perlobata schindewolfi* Müller; Schulze, p. 207, pl. 19, fig. 9 (with synonymy).

*Material*. BU 19218/1, 26, BU 19219/22.

*Remarks*. Glenister and Klapper (1966) declined to separate this from the subspecies *P. perlobata perlobata* on the grounds that the proposed characteristics of the two are inconsistent within single samples. They reported variation in terms of presence or absence of secondary carinae and of weak posterior or anterior direction of the inner lobe. Schulze (1968) retains *P. perlobata schindewolfi* but does not refer to Glenister and Klapper's view. Huddle (1968), in redescribing *Palmatolepis perlobata* Ulrich and Bassler, suggests, tentatively, that the more delicate and more finely ornamented *P. perlobata schindewolfi* may be distinct, but is unable to state the means of distinction concisely. In view of this present variety of opinion the name *P. perlobata schindewolfi* is employed again here. It appears to apply especially well to the specimen illustrated on Plate 47, figs. 1 and 2. The specimen illustrated in fig. 3 is more robust, more heavily ornamented, and may more closely resemble *P. perlobata perlobata* without finally matching any of the forms described by Huddle.

### *Palmatolepis rugosa trachytera* Ziegler 1960

Plate 47, fig. 7

1960 *Palmatolepis rugosa trachytera*, Ziegler in Kronberg, Pilger, Scherp, and Ziegler, p. 38, pl. 1, fig. 6, pl. 2, figs. 1–9.
1968 *Palmatolepis rugosa trachytera* Ziegler; Schulze, p. 208 (with synonymy).

*Material.* BU 19218/31.

### *Palmatolepis* sp. indet.

Plate 47, fig. 8

*Material.* BU 19218/2; BU 19219/23.

*Remarks.* This single large specimen is incompletely moulded. Those of its characters available for study (crestal profile, sharply projecting inner lobe, local fine ornament of nodes tending to be developed as short, near-radial ridges on the inner lobe) suggest similarity to *P. maxima* Müller 1956. It is, however, impossible to check the full form of the posterior part of the platform and the detail of the outer part.

### *Palmatolepis* sp.

Plate 47, fig. 4

*Material.* BU 19218/24.

*Remarks.* A small palmatolepid, whose outer character cannot be determined.

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EXPLANATION OF PLATE 47

Revultex pulls dusted with ammonium chloride. All magnifications ×30.

Figs. 1–3. *Palmatolepis perlobata schindewolfi* Müller. 1, Oral view, BU 19218/1. 2, Aboral view, BU 19219/22, of the individual seen in 1. 3, Oral view, BU 19218/26.

Fig. 4. *Palmatolepis* sp. BU 19218/24.

Figs. 5, 6. *Palmatolepis gonioclymeniae* Müller. 5, Oral view, BU 19219/19. 6, Aboral view, BU 19218/28, of the individual seen in 5.

Fig. 7. *Palmatolepis rugosa trachytera* Ziegler, BU 19218/31.

Fig. 8. *Palmatolepis* sp. indet. BU 19218/2.

Fig. 9. *Palmatolepis gracilis gracilis* Branson and Mehl BU 19218/25.

Figs. 10, 11. *Hindeodella segaformis* Bischoff. 10, Oral view, BU 19218/37. 11, Lateral view, BU 19219/21.

EXPLANATION OF PLATE 48

Revultex pulls dusted with ammonium chloride. All magnifications ×30.

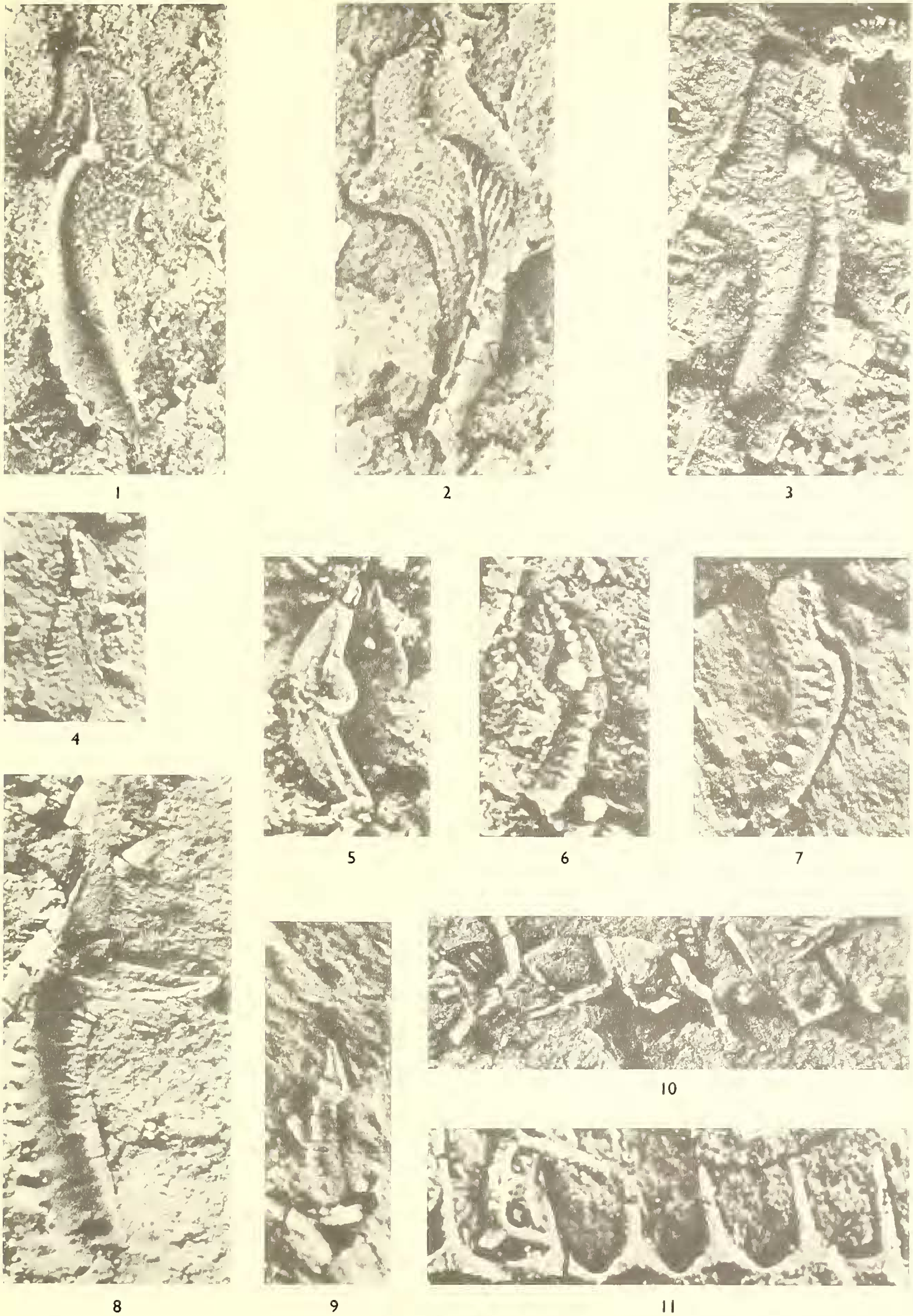
Fig. 1. *Polygnathus communis* Branson and Mehl. BU 19219/9.

Figs. 2, 7. *Pseudopolygnathus triangula triangula* Voges. 2, BU 19205/5. 7, BU 19218/10.

Figs. 3, 4, 8, 10, 11. *Pseudopolygnathus triangula pinnata* Voges. 3, BU 19205/1. 4, BU 19204. 8, BU 19219/8. 10, BU 19217/1. 11, BU 19205/4.

Figs. 5, 9. *Pseudopolygnathus* aff. *triangula* Voges. 5, Oral view, BU 19219/7. 9, Aboral view, BU 19218/7 of the individual seen in 5.

Fig. 6. *Pseudopolygnathus* sp. BU 19218/22.

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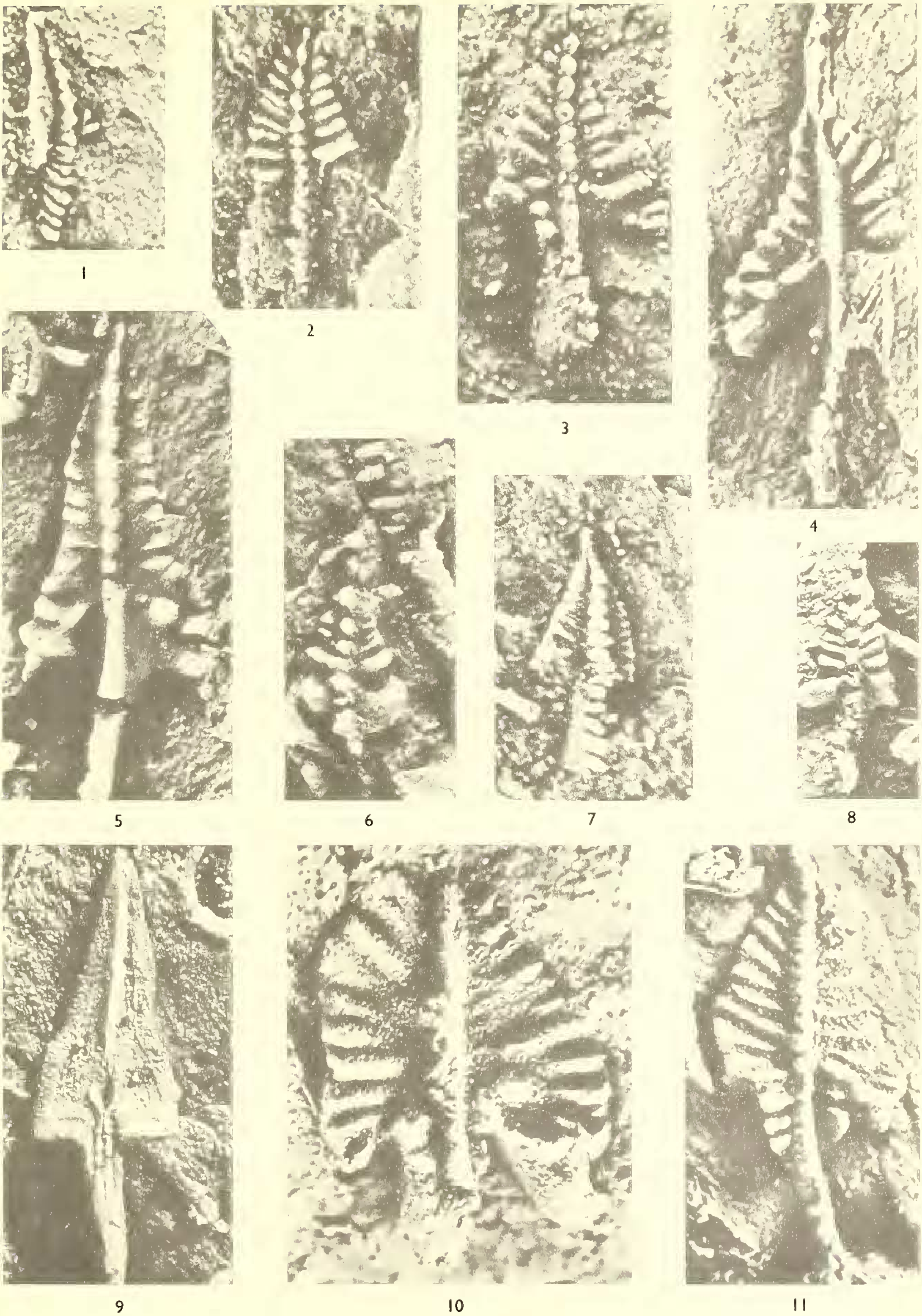


MATTHEWS, Conodonts from Cornwall